PATENT ABSTRACTS OF JAPAN

(11)Publication number : **05-266002**
(43)Date of publication of application : **15.10.1993**

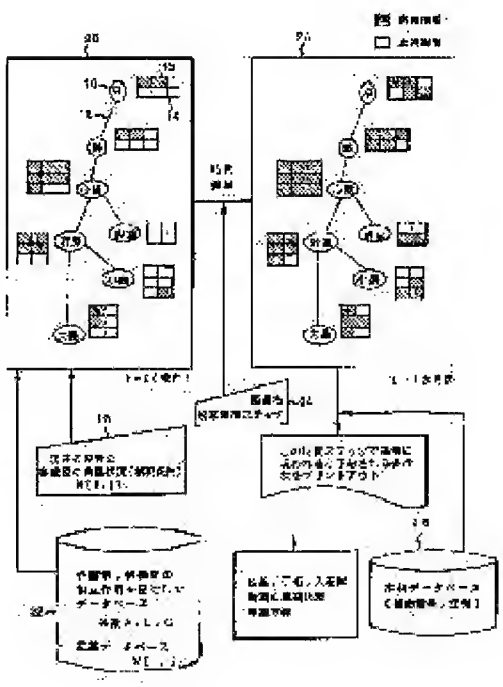
(51)Int.Cl. G06F 15/20
G06F 15/21
G06F 15/42

(21)Application number : **04-063063**
(22)Date of filing : **19.03.1992**

(71)Applicant : **HITACHI LTD**
(72)Inventor : **OKAMURA KEIJI**
MOTOIKE JUN
BAN HIDEYUKI
HASHIZUME AKIHIDE

(54) DISEASE CONDITION ESTIMATING SYSTEM APPLYING INTER-VISCOUS TISSUE NETWORK

(57)Abstract:
PURPOSE: To provide a disease condition estimating system which backs up a doctor to exactly estimate the progress of the disease condition of a patient without relying on the experiences of the doctor.
CONSTITUTION: Plural viscera which may possibly be morbid metastasis are connected to each other via the transfer paths and at the same time each viscus is divided into internal tissues in an inter-viscus tissue network model. Based on this model, a disease estimating system carries out the calculation to estimate the change of the disease condition. Then a processor of this system estimates the capacity rate of each internal tissue to be morbid at an optional future time point based on a data base 22 related to the self-growing speed, the inter- tissue metastasis frequency statistics, and the inter-viscus metastasis frequency statistics and also based on the capacity rate of the tissue to be morbid set against the total capacity of each internal tissue of the relevant patient inputted as the initial conditions 18.



CLAIMS

[Claim(s)]

[Claim 1]A condition-of-disease prediction system comprising:

Two or more organs which have the metastability of a lesion by body fluid circulation are combined in the transition course, And an interactive input device for being a condition-of-disease prediction system which performs lesion prediction computation based on a network model between organ organizations which divided each organ into two or more internal tissue, and inputting medication data in the middle of an initial condition of lesion prediction computation, and lesion advance.

A database accumulation means which accumulated a database about self-multiplication speed of a focus organization, metastasis frequency statistics between organizations, and metastasis frequency statistics between organs.

A processing unit which has accessed the above-mentioned database accumulation means from a rate of capacity of diseased tissue to full capacity for every internal tissue of an object patient inputted as an initial condition, and carries out prediction computation of the rate of capacity of diseased tissue for every arbitrary above-mentioned internal tissue at the future time.

A displaying means which displays a result of prediction computation.

[Claim 2]The condition-of-disease prediction system according to claim 1, wherein prediction computation of the above-mentioned processing unit is performed by an equation including a paragraph proportional to a square of a rate of capacity of one's structure number corresponding to self-multiplication of a pathogen cell, and a paragraph of a product of a rate of capacity of a different structure number corresponding to transition from other organizations.

[Claim 3]The above-mentioned database accumulation means is what accumulates further a medication database in which a recovery structure number corresponding to a chemical name and its recovery speed are shown, The condition-of-disease prediction system according to claim 1, wherein the above-mentioned processing unit carries out prediction computation of the rate of capacity of diseased tissue for every above-mentioned internal tissue at the time of [arbitrary / future] considering reactions of medication for medication data and the above in the middle of the above-mentioned lesion advance using a medication database.

[Claim 4]The condition-of-disease prediction system according to claim 1, wherein the above-mentioned database accumulation means accumulates further a case data base created considering a rate of capacity and manifestation condition of diseased tissue as a search key item.

[Claim 5]The condition-of-disease prediction system according to claim 4 the above-mentioned processing unit's resorting each organ and a rate of capacity of diseased tissue of each

organization which were obtained by a result of prediction computation in descending order, and searching the above-mentioned case data base sequentially from diseased tissue with a large rate of capacity by making a corresponding structure number into a key item.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the supporting system for a medical practitioner's medication to cancer etc., an operation, and the early determination of a hospitalization-and-release stage. It is related with a system available although the future state of focus distribution of the patient who has fallen into alcohol dependence, chronic poisoning, etc. is predicted and shown. It is also possible to use for an initial condition as a study simulator system which trains the EKUSU part nature in a medical practitioner's medication in inputting virtual focus distribution and virtual medication data.

[0002]

[Description of the Prior Art]The medication to a patient, a patient's operation, and the determination of the hospitalization-and-release stage depend the many on a medical practitioner's experience now. Although some researches of the optimal medication supporting system at the time of a gastric cancer therapy are presented, it has stopped at the supporting system which all restricted in each organ. As latest example, a future condition-of-disease advance is predicted probable in National Cancer Center by arranging statistically the medical-examination clinical recording for the past ten years, and enriching a case data base. The application of the mathematical theory to the prediction of epidemics of an infectious disease or treatment planning of leukemia is reported. A condition-of-disease diagnosis support system is built from clinical laboratory test information, and there is a report of Kawasaki Medical School which evaluated the prognosis (are them remission or death?) as a statistical distinction value to the illness of a risk.

[0003]

[Problem(s) to be Solved by the Invention]Now, the medication to a patient, a patient's operation, and the determination of a hospitalization-and-release stage are largely based on a medical practitioner's experience. And rationalization of rationalization of a patient number, an operation, or a medication stage serves as an important technical problem now when the shortage of a number of hospital bed and the shortage of a nurse are cried for. The point which neither progression of condition of disease nor reactions of medication make information-on-forecast offer about the focus of two or more mutually related organs, and supports a medical practitioner's overall assessment was not enough as the supporting system of the conventional medication judgment, or the prediction system of condition-of-disease advance as a supporting system of a medical practitioner's study, either.

[0004]One purpose of this invention is to provide the condition-of-disease prediction system which supports what the curative effect by a future condition-of-disease advance or medication is not depended on experience about two or more mutually related organs, but a medical practitioner predicts exactly.
[0005]Other purposes of this invention set up a patient's lesion condition in early stages virtually, and there are in providing the condition-of-disease prediction system which can advise on the optimal medication stage.
[0006]Other purposes of this invention are to provide a condition-of-disease prediction system suitable for not being based on real experience but learning prediction and reactions of medication of a lesion state.
[0007]
[Means for Solving the Problem]An interactive input device for a system of this invention to input medication data in the middle of an initial condition of lesion prediction computation, and lesion advance, A database accumulation means, a processing unit for performing computation, and a display for showing a medical practitioner a prediction computation result are included, Condition-of-disease prediction processing is performed based on a network model between organ organizations which combined two or more organs which have the metastability of a lesion by body fluid circulation in the transition course, and divided each organ into two or more internal tissue. As an initial condition, a rate of capacity of diseased tissue to full capacity for every internal tissue of each above-mentioned organ of an object patient is inputted, and a database about self-multiplication speed of a focus organization, metastasis frequency statistics between organizations, and metastasis frequency statistics between organs is beforehand accumulated at least as a database. A processing unit performs prediction computation which asks for a rate of diseased tissue capacity of each arbitrary organization at the future time using a rate of capacity and the above-mentioned database of diseased tissue for every internal tissue of an initial condition.
[0008]Another feature of this invention the above-mentioned database accumulation means, Are accumulating further a case data base created considering a rate of capacity and manifestation condition of diseased tissue as a search key item, and the above-mentioned processing unit, It is in a point of resorting each organ and a rate of capacity of diseased tissue of each organization which were obtained by a result of prediction computation in descending order, and searching the above-mentioned case data base sequentially from diseased tissue with a large rate of capacity by making a corresponding structure number into a key item.
[0009]Another feature of this invention is that in which a database accumulation means accumulates further a medication database in which a recovery structure number corresponding to a chemical name and its recovery speed are shown, The above-mentioned processing unit is at a point which carries out prediction computation of the rate of capacity of diseased tissue for every above-mentioned internal tissue at the time of [arbitrary / future] considering reactions of medication for medication data and the above in the middle of the above-mentioned lesion advance using a medication database.

[0010]Software of a processing unit in a typical example of this invention consists of the following subroutine.
[0011](1) Each organ and a rate distribution map of capacity of diseased tissue of an organization are outputted by a certain time step, (2) Calculate a rate of capacity of the following time step under a set-up organ and an interaction of an organization, (3) Output condition which sorts a rate of capacity to descending of a value, searches a case data base by making a structure number corresponding to them into a search key item, and is presented to a patient at the time, (4) In a time step beforehand specified in a medication database, take out the object structure number and recovery speed by making the medication chemical name into a key item, and change rate data of capacity.
[0012]
[Function]According to this invention, the expert nature in advance prediction of the illness, and the medication, the operation and the determination of a hospitalization-and-release stage for which it opted by a doctor's discretion conventionally is realizable on software. A medical practitioner is supportable so that a big difference may not arise in the condition of a patient's after that according to the difference of discretion by the existence of a medical practitioner's experience by this.
[0013]
[Example]Drawing 1 is a figure showing the outline of the prediction system of the example of this invention. In the inside 20 and 26 of a figure, the network model between organ organizations made into the object of the prediction computation in a processing unit is shown. The network model between these organ organizations combined two or more organs 10 which have the metastability of a lesion by body fluid circulation in that transition course 12, and divided each organ into two or more internal tissue. for example, a brain -- 4 is attached for 3 and the stomach and each organ is numbered [1 and a lung / 2 and the heart] for liver like 5 and ... Each organ is divided into two or more internal tissue, and a number is given in order. In describing an organ number and a structure number as a conclusion (5, 2), it means the 2nd tissue of liver. The rate of the diseased tissue capacity occupied to the full capacity of an organization (i, j) is defined as N (i, j). Generally N takes or more 0 one or less domain here, and it means that N= 0 is normal tissue.
[0014]This time, i.e., the medical checkup result of N (i, j) of the patient of the object in t= 0, is inputted into a prediction system as the initial condition 18 of prediction computation. As an appraisal method of N (i, j), the numerical value which broke viewing or the area of the lesion distinguished automatically by the front product of the candidate organization, for example from CT or roentgenography is used. The initial condition 18 consists of a name of patient, an illness name, the organ number i, the structure numbers j, and those N (i, j), and, specifically, is inputted from an interactive input device.
[0015]A processing unit outputs data to a display according to an initial condition input in order to perform the display shown in 20 of drawing 1. The rectangle 14 in a figure corresponds to each organization, and the zone 15 by which hatching was carried out expresses the organization

which is more than a threshold with N. By expressing and displaying an object patient's present lesion distribution on such a network model between organ organizations, a patient's condition of disease or an operation, and medication can grasp a required organization in a visual image. Another style of lesion distribution is the method of making the value and color of N of each organ correspond, and displaying on a color outputting device. [of each internal tissue] For example, the color of a warm color system is specified as the value of N becomes large, and normal tissue does cold color expression.

[0016]A processing unit dispels growth of a lesion, and transition mathematically as a time development problem. For this reason, the nonlinear differential equation about the rate of a temporal change of N is introduced. If the rate of a temporal change of N (i, j) is set to M (i, j), It not only depends for this variable dependency on N (i, k) of the organization (i, k) which adjoins (i, j) other than self-multiplication, but it depends for it on N (m, n) of other organ organizations (m, n) (m is not equal to i) through a network with other organs. Therefore, the following three paragraphs describe M (i, j).

1. Self-multiplication : this is proportional to the square of N (i, j). a proportionality coefficient -- A (i, j) -- or abbreviated is carried out and it is referred to as A.

2. Transition from other organizations (i, k) in the same organ : this is proportional to the product of N (i, j) and N (i, k). a proportionality coefficient -- B (i, j, i, k) -- or abbreviated is carried out and it is referred to as B.

3. Transition from other organizations (m, n) of a different organ : this is proportional to the product of N (i, j) and N (m, n). a proportionality coefficient -- C (i, j, m, n) -- or abbreviated is carried out and it is referred to as C.

[0017]As mentioned above, M (i, j) is M(i, j) =A(i, j) *N(i, j) *N(i, j)+B(i,j,i, k) *N(i, j) *N(i, k)+C(i,j,m, n) *N(i, j) *N (m, n).

(Several 1)

It becomes. Since the left side of (several 1) is a rate of a temporal change, it evaluates M (i, j) by (several 2) according to evaluation of a finite difference method as a difference of N' (i, j) after 1 time step, and the present N (i, j).

M (i, j) = (N' (i, j) - N (i, j)) / DT (several 2)

DT is 1 time-step width here.

[0018]If N (i, j) of a certain time step is given from (several 1) and (several 2), N' (i, j) after the 1 time step is calculable by (3).

N'(i,j)=N(i,j)+DT{A(i,j)*N(i,j)*N(i,j)+ B(i,j,i,k)*N(i,j)*N(i,k)+ C(i,j,m,n)*N(i,j)*N(m,n)}

(Several 3)

It is N(i, j) =N' (i, j) to all the i after calculating (several 3), and j (several 4).

It sets and calculation of (1) and (2) is repeated again.

[0019]The coefficient A of (several 3) interpolates the proliferation profile of a cell number when carrying out self-culture of the focus tissue cell in the curve of A*N*N, and determines it. A coefficient B and C create the organization transition data of the illness as follows from the clinical data about the corresponding illness. About transition to (i, j) from other organizations

(m, n) of an organ which is different about transition to (i, j) from other organizations (i, k) in the same organ, the transition number database is built by drawing 4 and a list item like drawing 5, respectively. In drawing 4, it is considered as i, j, k, and the transition number, and i, j, m, n, and the transition number are made into the key item in drawing 5. Namely, the database of the coefficient A obtained as data of the interaction between each organ and an organization to the database accumulation means 22 of drawing 1 as a result of self-culture of the focus organization of each internal tissue of each organ, The database of the coefficient C computed from the database of the coefficient B computed from the database of the transfer number between the organizations in the organ shown in drawing 4 and the database of the transfer number between the organs shown in drawing 5 is contained. a processing unit repeats calculation of (several 3) using the inputted initial conditions and these data ** bases -- future arbitrary times -- N' (i, j) value of t (for example, one month after) -- each (i, j) -- ******** -- it asks. It displays, as the result is outputted to a display like early lesion distribution, for example, it is shown in 26 of drawing 1.

[0020]According to the system which performs the above lesion distribution prediction and a display, judgment of medical practitioners, such as a hospitalization stage, a medication stage, and an operation stage, can be supported, without being based on real experience. It is effective as a supporting system of a medical practitioner's study.

[0021]The medication database which recorded V (i, j) is accumulated in the organ number i which makes a chemical name further the database accumulation means 22 of the example of drawing 1 with a search key, and recovers with the medicine, the structure number j, and recovery speed. Calculation of the future condition-of-disease prediction mentioned above can be performed by assuming having prescribed a medicine for the patient at a certain stage, and considering the recovery effect by it.

[0022]That is, the array variable F (t) which shows whether a medicine is prescribed for each time step i of every is stood. It means that F(t) =0 does not prescribe a medicine for the patient by this time step, and means that F(i)=1 prescribes a medicine for the patient. This array variable F (t) is created with a processing unit by inputting the data 24 of a chemical name and medication time into an interactive input device. In calculation of (several 3) and (several 4), this flag is checked for every time step, and if it becomes F(t) =1, change calculation of N by the following medication will be performed to t. A medication database is first searched with this change calculation by using a chemical name as a search key, and V (i, j) is outputted for the organ number i which recovers with medicine, the structure number j, and recovery speed from a medication database by it. Next, it is N'(i, j) =N' (i, j) *exp (-V(i, j) *DT) about N' in the next time step at the time of F(t) =1 (several 5).

The prediction computation of the lesion distribution which considered reactions of medication becomes possible by replacing.

[0023]The process flow in the processing unit at the time of considering the recovery effect by this medication is shown in drawing 2. It displays on a display like 26 of drawing 1 as only the specified number of times of a step repeated the operation, calculated the future value of N from

all the i and j and was described previously. By such prediction processing, various medication stages can be set up, transition of condition of disease can be expected, and it is useful for judgment of a suitable medication stage.
[0024]In the example of drawing 1, the condition predicted to appear in a patient then from the lesion distribution at the time of there being a future acquired by doing in this way is illustrated. For this reason, the processing unit with which a condition-of-disease prediction system is provided with the case data base 28 which listed the case corresponding to the rate of capacity of the diseased tissue of each organization of each organ processes the flow shown in drawing 3. The predicted value N of the rate of capacity of the diseased tissue for every internal tissue of each organ obtained by calculating first (i, j) is sorted in descending order of a value. Next, a case data base is searched from descending of the rate of capacity by making a corresponding structure number into a search key item. These case items are outputted to a display. For example, an output-statement character foreground color is divided with the value of N, it is a warm color system and, as for an urgent case, it is preferred that a cold color system displays on the low case of urgency. Cautions can be demanded from a medical practitioner by blinking a character representation to the case which requires an urgent therapy especially etc.
[0025]
[Effect of the Invention]According to this invention, what the curative effect by a future condition-of-disease advance or medication is not depended on experience about two or more mutually related organs, but a medical practitioner predicts exactly is supportable as mentioned above. Therefore, it enables a medical practitioner to judge appropriately a medication stage, a hospitalization stage, or an operation stage. It is effective even if it uses for the warning to the patient who was alike and has fallen into alcohol dependence, chronic poisoning, etc. further.

TECHNICAL FIELD

[Industrial Application]This invention relates to the supporting system for a medical practitioner's medication to cancer etc., an operation, and the early determination of a hospitalization-and-release stage. It is related with a system available although the future state of focus distribution of the patient who has fallen into alcohol dependence, chronic poisoning, etc. is predicted and shown. It is also possible to use for an initial condition as a study simulator system which trains the EKUSU part nature in a medical practitioner's medication in inputting virtual focus distribution and virtual medication data.

PRIOR ART

[Description of the Prior Art]The medication to a patient, a patient's operation, and the determination of the hospitalization-and-release stage depend the many on a medical practitioner's experience now. Although some researches of the optimal medication supporting system at the time of a gastric cancer therapy are presented, it has stopped at the supporting

system which all restricted in each organ. As latest example, a future condition-of-disease advance is predicted probable in National Cancer Center by arranging statistically the medical-examination clinical recording for the past ten years, and enriching a case data base. The application of the mathematical theory to the prediction of epidemics of an infectious disease or treatment planning of leukemia is reported. A condition-of-disease diagnosis support system is built from clinical laboratory test information, and there is a report of Kawasaki Medical School which evaluated the prognosis (are them remission or death?) as a statistical distinction value to the illness of a risk.

EFFECT OF THE INVENTION

[Effect of the Invention]According to this invention, what the curative effect by a future condition-of-disease advance or medication is not depended on experience about two or more mutually related organs, but a medical practitioner predicts exactly is supportable as mentioned above. Therefore, it enables a medical practitioner to judge appropriately a medication stage, a hospitalization stage, or an operation stage. It is effective even if it uses for the warning to the patient who was alike and has fallen into alcohol dependence, chronic poisoning, etc. further.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]Now, the medication to a patient, a patient's operation, and the determination of a hospitalization-and-release stage are largely based on a medical practitioner's experience. And rationalization of rationalization of a patient number, an operation, or a medication stage serves as an important technical problem now when the shortage of a number of hospital bed and the shortage of a nurse are cried for. The point which neither progression of condition of disease nor reactions of medication make information-on-forecast offer about the focus of two or more mutually related organs, and supports a medical practitioner's overall assessment was not enough as the supporting system of the conventional medication judgment, or the prediction system of condition-of-disease advance as a supporting system of a medical practitioner's study, either.

[0004]One purpose of this invention is to provide the condition-of-disease prediction system which supports what the curative effect by a future condition-of-disease advance or medication is not depended on experience about two or more mutually related organs, but a medical practitioner predicts exactly.

[0005]Other purposes of this invention set up a patient's lesion condition in early stages virtually, and there are in providing the condition-of-disease prediction system which can advise on the optimal medication stage.

[0006]Other purposes of this invention are to provide a condition-of-disease prediction system suitable for not being based on real experience but learning prediction and reactions of medication of a lesion state.

MEANS

[Means for Solving the Problem]An interactive input device for a system of this invention to input medication data in the middle of an initial condition of lesion prediction computation, and lesion advance, A database accumulation means, a processing unit for performing computation, and a display for showing a medical practitioner a prediction computation result are included, Condition-of-disease prediction processing is performed based on a network model between organ organizations which combined two or more organs which have the metastability of a lesion by body fluid circulation in the transition course, and divided each organ into two or more internal tissue. As an initial condition, a rate of capacity of diseased tissue to full capacity for every internal tissue of each above-mentioned organ of an object patient is inputted, and a database about self-multiplication speed of a focus organization, metastasis frequency statistics between organizations, and metastasis frequency statistics between organs is beforehand accumulated at least as a database. A processing unit performs prediction computation which asks for a rate of diseased tissue capacity of each arbitrary organization at the future time using a rate of capacity and the above-mentioned database of diseased tissue for every internal tissue of an initial condition.

[0008]Another feature of this invention the above-mentioned database accumulation means, Are accumulating further a case data base created considering a rate of capacity and manifestation condition of diseased tissue as a search key item, and the above-mentioned processing unit, It is in a point of resorting each organ and a rate of capacity of diseased tissue of each organization which were obtained by a result of prediction computation in descending order, and searching the above-mentioned case data base sequentially from diseased tissue with a large rate of capacity by making a corresponding structure number into a key item.

[0009]Another feature of this invention is that in which a database accumulation means accumulates further a medication database in which a recovery structure number corresponding to a chemical name and its recovery speed are shown, The above-mentioned processing unit is at a point which carries out prediction computation of the rate of capacity of diseased tissue for every above-mentioned internal tissue at the time of [arbitrary / future] considering reactions of medication for medication data and the above in the middle of the above-mentioned lesion advance using a medication database.

[0010]Software of a processing unit in a typical example of this invention consists of the following subroutine.

[0011](1) Each organ and a rate distribution map of capacity of diseased tissue of an organization are outputted by a certain time step, (2) Calculate a rate of capacity of the following time step under a set-up organ and an interaction of an organization, (3) Output condition which sorts a rate of capacity to descending of a value, searches a case data base by making a structure number corresponding to them into a search key item, and is presented to a patient at the time, (4) In a time step beforehand specified in a medication database, take out the object structure

number and recovery speed by making the medication chemical name into a key item, and change rate data of capacity.

OPERATION

[Function]According to this invention, the expert nature in advance prediction of the illness, and the medication, the operation and the determination of a hospitalization-and-release stage for which it opted by a doctor's discretion conventionally is realizable on software. A medical practitioner is supportable so that a big difference may not arise in the condition of a patient's after that according to the difference of discretion by the existence of a medical practitioner's experience by this.

EXAMPLE

[Example]Drawing 1 is a figure showing the outline of the prediction system of the example of this invention. In the inside 20 and 26 of a figure, the network model between organ organizations made into the object of the prediction computation in a processing unit is shown. The network model between these organ organizations combined two or more organs 10 which have the metastability of a lesion by body fluid circulation in that transition course 12, and divided each organ into two or more internal tissue. for example, a brain -- 4 is attached for 3 and the stomach and each organ is numbered [1 and a lung / 2 and the heart] for liver like 5 and ... Each organ is divided into two or more internal tissue, and a number is given in order. In describing an organ number and a structure number as a conclusion (5, 2), it means the 2nd tissue of liver. The rate of the diseased tissue capacity occupied to the full capacity of an organization (i, j) is defined as N (i, j). Generally N takes or more 0 one or less domain here, and it means that N= 0 is normal tissue.

[0014]This time, i.e., the medical checkup result of N (i, j) of the patient of the object in t= 0, is inputted into a prediction system as the initial condition 18 of prediction computation. As an appraisal method of N (i, j), the numerical value which broke viewing or the area of the lesion distinguished automatically by the front product of the candidate organization, for example from CT or roentgenography is used. The initial condition 18 consists of a name of patient, an illness name, the organ number i, the structure numbers j, and those N (i, j), and, specifically, is inputted from an interactive input device.

[0015]A processing unit outputs data to a display according to an initial condition input in order to perform the display shown in 20 of drawing 1. The rectangle 14 in a figure corresponds to each organization, and the zone 15 by which hatching was carried out expresses the organization which is more than a threshold with N. By expressing and displaying an object patient's present lesion distribution on such a network model between organ organizations, a patient's condition of disease or an operation, and medication can grasp a required organization in a visual image. Another style of lesion distribution is the method of making the value and color of N of each

organ correspond, and displaying on a color outputting device. [of each internal tissue] For example, the color of a warm color system is specified as the value of N becomes large, and normal tissue does cold color expression.

[0016]A processing unit dispels growth of a lesion, and transition mathematically as a time development problem. For this reason, the nonlinear differential equation about the rate of a temporal change of N is introduced. If the rate of a temporal change of N (i, j) is set to M (i, j), It not only depends for this variable dependency on N (i, k) of the organization (i, k) which adjoins (i, j) other than self-multiplication, but it depends for it on N (m, n) of other organ organizations (m, n) (m is not equal to i) through a network with other organs. Therefore, the following three paragraphs describe M (i, j).

1. Self-multiplication : this is proportional to the square of N (i, j). a proportionality coefficient -- A (i, j) -- or abbreviated is carried out and it is referred to as A.

2. Transition from other organizations (i, k) in the same organ : this is proportional to the product of N (i, j) and N (i, k). a proportionality coefficient -- B (i, j, i, k) -- or abbreviated is carried out and it is referred to as B.

3. Transition from other organizations (m, n) of a different organ : this is proportional to the product of N (i, j) and N (m, n). a proportionality coefficient -- C (i, j, m, n) -- or abbreviated is carried out and it is referred to as C.

[0017]As mentioned above, M (i, j) is M(i, j) =A(i, j) *N(i, j) *N(i, j)+B(i,j,i, k) *N(i, j) *N(i, k)+C(i,j,m, n) *N(i, j) *N (m, n).

(Several 1)

It becomes. Since the left side of (several 1) is a rate of a temporal change, it evaluates M (i, j) by (several 2) according to evaluation of a finite difference method as a difference of N' (i, j) after 1 time step, and the present N (i, j).

M (i, j) = (N' (i, j) - N (i, j)) / DT (several 2)

DT is 1 time-step width here.

[0018]If N (i, j) of a certain time step is given from (several 1) and (several 2), N' (i, j) after the 1 time step is calculable by (3).

N'(i,j)=N(i,j)+DT{A(i,j)*N(i,j)*N(i,j)+ B(i,j,i,k)*N(i,j)*N(i,k)+ C(i,j,m,n)*N(i,j)*N(m,n)}

(Several 3)

as opposed to all the i after calculating (several 3), and j -- N(i, j) =N' (i, j) (several 4)

It sets and calculation of (1) and (2) is repeated again.

[0019]The coefficient A of (several 3) interpolates the proliferation profile of a cell number when carrying out self-culture of the focus tissue cell in the curve of A*N*N, and determines it. A coefficient B and C create the organization transition data of the illness as follows from the clinical data about the corresponding illness. About transition to (i, j) from other organizations (m, n) of an organ which is different about transition to (i, j) from other organizations (i, k) in the same organ, the transition number database is built by drawing 4 and a list item like drawing 5, respectively. In drawing 4, it is considered as i, j, k, and the transition number, and i, j, m, n, and the transition number are made into the key item in drawing 5. Namely, the database of the

coefficient A obtained as data of the interaction between each organ and an organization to the database accumulation means 22 of drawing 1 as a result of self-culture of the focus organization of each internal tissue of each organ, The database of the coefficient C computed from the database of the coefficient B computed from the database of the transfer number between the organizations in the organ shown in drawing 4 and the database of the transfer number between the organs shown in drawing 5 is contained. a processing unit repeats calculation of (several 3) using the inputted initial conditions and these data ** bases -- future arbitrary times -- N' (i, j) value of t (for example, one month after) -- each (i, j) -- ******** -- it asks. It displays, as the result is outputted to a display like early lesion distribution, for example, it is shown in 26 of drawing 1.

[0020]According to the system which performs the above lesion distribution prediction and a display, judgment of medical practitioners, such as a hospitalization stage, a medication stage, and an operation stage, can be supported, without being based on real experience. It is effective as a supporting system of a medical practitioner's study.

[0021]The medication database which recorded V (i, j) is accumulated in the organ number i which makes a chemical name further the database accumulation means 22 of the example of drawing 1 with a search key, and recovers with the medicine, the structure number j, and recovery speed. Calculation of the future condition-of-disease prediction mentioned above can be performed by assuming having prescribed a medicine for the patient at a certain stage, and considering the recovery effect by it.

[0022]That is, the array variable F (t) which shows whether a medicine is prescribed for each time step i of every is stood. It means that F(t) =0 does not prescribe a medicine for the patient by this time step, and means that F(i)=1 prescribes a medicine for the patient. This array variable F (t) is created with a processing unit by inputting the data 24 of a chemical name and medication time into an interactive input device. In calculation of (several 3) and (several 4), this flag is checked for every time step, and if it becomes F(t) =1, change calculation of N by the following medication will be performed to t. A medication database is first searched with this change calculation by using a chemical name as a search key, and V (i, j) is outputted for the organ number i which recovers with medicine, the structure number j, and recovery speed from a medication database by it. Next, it is N'(i, j) =N' (i, j) *exp (-V(i, j) *DT) about N' in the next time step at the time of F(t) =1 (several 5).

The prediction computation of the lesion distribution which considered reactions of medication becomes possible by replacing.

[0023]The process flow in the processing unit at the time of considering the recovery effect by this medication is shown in drawing 2. It displays on a display like 26 of drawing 1 as only the specified number of times of a step repeated the operation, calculated the future value of N from all the i and j and was described previously. By such prediction processing, various medication stages can be set up, transition of condition of disease can be expected, and it is useful for judgment of a suitable medication stage.

[0024]In the example of drawing 1, the condition predicted to appear in a patient then from the

lesion distribution at the time of there being a future acquired by doing in this way is illustrated. For this reason, the processing unit with which a condition-of-disease prediction system is provided with the case data base 28 which listed the case corresponding to the rate of capacity of the diseased tissue of each organization of each organ processes the flow shown in drawing 3. The predicted value N of the rate of capacity of the diseased tissue for every internal tissue of each organ obtained by calculating first (i, j) is sorted in descending order of a value. Next, a case data base is searched from descending of the rate of capacity by making a corresponding structure number into a search key item. These case items are outputted to a display. For example, an output-statement character foreground color is divided with the value of N, it is a warm color system and, as for an urgent case, it is preferred that a cold color system displays on the low case of urgency. Cautions can be demanded from a medical practitioner by blinking a character representation to the case which requires an urgent therapy especially etc.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a key map showing the outline composition of the prediction system of this invention.

[Drawing 2]It is a flow chart of time development calculation of an example.

[Drawing 3]It is a flow chart which outputs a case from the rate of capacity in the final step of time development calculation of an example.

[Drawing 4]It is a figure showing the transition number database structure between different organizations in the same organ of an example.

[Drawing 5]It is a figure showing the transition number database structure between the organizations between the organs from which an example differs.

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開平5－266002

(43)公開日　平成５年(1993)10月15日

(51)Int.Cl.[5]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｇ０６Ｆ　15/20		Ｆ　7218－5Ｌ		
15/21	３６０	7218－5Ｌ		
15/42		Ｄ　7060－5Ｌ		

審査請求　未請求　請求項の数５(全　８　頁)

(21)出願番号　特願平4－63063

(22)出願日　平成４年(1992)３月19日

(71)出願人　000005108
株式会社日立製作所
東京都千代田区神田駿河台四丁目６番地

(72)発明者　岡村　敬二
東京都国分寺市東恋ケ窪１丁目280番地
株式会社日立製作所中央研究所内

(72)発明者　本池　順
東京都国分寺市東恋ケ窪１丁目280番地
株式会社日立製作所中央研究所内

(72)発明者　伴　秀行
東京都国分寺市東恋ケ窪１丁目280番地
株式会社日立製作所中央研究所内

(74)代理人　弁理士　小川　勝男

最終頁に続く

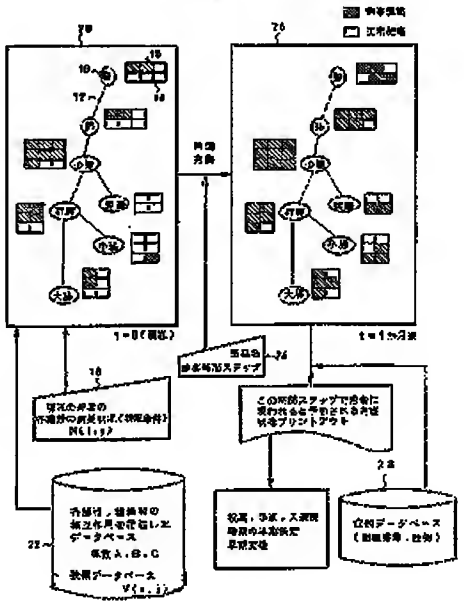
(54)【発明の名称】　臓器組織間ネットワークによる病状予測システム

(57)【要約】

【目的】　経験によらず医師が的確に患者のこれからの病状進行を予測することを支援するシステムを提供する。

【構成】　病変の転移可能性のある複数の臓器をその転移経路で結合し，かつ各臓器を複数の内部組織に分割した臓器組織間ネットワークモデルをもとに病変予測計算を行う病状予測システムであり，病巣組織の自己増殖速度，組織間の転移頻度統計，及び臓器間の転移頻度統計に関するデータベース２２と，初期条件１８として入力された対象患者の各内部組織ごとの全容量に対する病変組織の容量率から任意の将来の時点の上記各内部組織ごとの病変組織の容量率を処理装置で予測計算し，その結果を２６のように表示する。

図１



1

【特許請求の範囲】

【請求項１】体液循環により病変の転移可能性のある複数の臓器をその転移経路で結合し、かつ各臓器を複数の内部組織に分割した臓器組織間ネットワークモデルをもとに病変予測計算を行う病状予測システムであり、病変予測計算の初期条件と病変進行途中における投薬データを入力するための対話型入力装置と、病巣組織の自己増殖速度、組織間の転移頻度統計、及び臓器間の転移頻度統計に関するデータベースを蓄積したデータベース蓄積手段と、初期条件として入力された対象患者の各内部組織ごとの全容量に対する病変組織の容量率から上記データベース蓄積手段をアクセスしてて任意の将来の時点の上記各内部組織ごとの病変組織の容量率を予測計算する処理装置と、予測計算の結果を表示する表示手段を含むことを特徴とする病状予測システム。

【請求項２】上記処理装置の予測計算は、病原細胞の自己増殖に対応する自らの組織番号の容量率の２乗に比例する項と他の組織からの転移に対応する異なる組織番号の容量率の積の項を含む方程式により実行されることを特徴とする請求項１に記載の病状予測システム。

【請求項３】上記データベース蓄積手段は薬品名に対応する治癒組織番号とその治癒速度を示す投薬データベースを更に蓄積するものであり、上記処理装置は上記病変進行途中における投薬データと上記を投薬データベースを用いて投薬効果を加味した任意の将来の時点の上記各内部組織ごとの病変組織の容量率を予測計算することを特徴とする請求項１に記載の病状予測システム。

【請求項４】上記データベース蓄積手段は、病変組織の容量率と発現症状を検索キー項目として作成された症例データベースをさらに蓄積することを特徴とする請求項１に記載の病状予測システム。

【請求項５】上記処理装置は、予測計算の結果で得た各臓器、各組織の病変組織の容量率を降順にソートし直し、対応する組織番号をキー項目として容量率の大きい病変組織から順に上記症例データベースを検索することを特徴とする請求項４に記載の病状予測システム。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は癌などに対する医師の投薬、手術、入退院時期の早期決定のための支援システムに関する。また、アルコール依存症や慢性的な中毒などに陥っている患者の病巣分布の将来の状態を予測して提示するのに利用可能なシステムに関する。さらに、初期条件に仮想的な病巣分布と仮想的な投薬データを入力することで医師の投薬におけるエクスパート性を訓練する学習シミュレータシステムとして利用することも可能である。

【０００２】

【従来の技術】現在患者への投薬、患者の手術、入退院時期の決定はその多くを医師の経験によっている。胃癌治療時の最適投薬支援システムの研究がいくつか発表されているが、いずれも各々の臓器内に限った支援システムに留まっている。最近の例として、国立癌センターでは過去１０年間の診療カルテを統計的に整理し症例データベースを充実させることで今後の病状進行を確率的に予測している。また感染症の流行予測や白血病の治療計画への数理モデルの応用例が報告されている。さらに、臨床検査情報から病状診断支援システムを構築し、リスクの疾病に対して予後（軽快か死亡か）を統計的な判別値として評価した川崎医科大学の報告がある。

【０００３】

【発明が解決しようとする課題】現在、患者への投薬、患者の手術、入退院時期の決定は医師の経験によるところが大きい。しかも病床数不足や看護婦不足が叫ばれている今、患者数の適正化、手術もしくは投薬時期の適正化は重要な課題となる。従来の投薬判断の支援システムや病状進行の予測システムは相互に関連する複数の臓器の病巣について病状の進行や投薬効果の予測情報提供するものでなく、医師の総合的判断を支援する点でも、また医師の学習の支援システムとしても十分ではなかった。

【０００４】本発明のひとつの目的は、相互に関連する複数の臓器についてこれからの病状進行、もしくは投薬による治療効果を、経験によらず医師が的確に予測することを支援する病状予測システムを提供することにある。

【０００５】本発明の他の目的は、初期に仮想的に患者の病変状態を設定し、最適投薬時期をアドバイスできる病状予測システムを提供することにある。

【０００６】本発明の他の目的は、実経験によらず病変状態の予測や投薬効果を学習するのに適した病状予測システムを提供することにある。

【０００７】

【課題を解決するための手段】本発明のシステムは、病変予測計算の初期条件と病変進行途中における投薬データを入力するための対話型入力装置と、データベース蓄積手段と、計算処理を行なうための処理装置と、予測計算結果を医師に提示するための表示装置とを含み、体液循環により病変の転移可能性のある複数の臓器をその転移経路で結合し、かつ各臓器を複数の内部組織に分割した臓器組織間ネットワークモデルをもとに病状予測処理を行う。初期条件としては対象患者の上記各臓器の各内部組織ごとの全容量に対する病変組織の容量率が入力され、データベースとしては少なくとも病巣組織の自己増殖速度、組織間の転移頻度統計、及び臓器間の転移頻度統計に関するデータベースが予め蓄積されている。処理装置は初期条件の各内部組織ごとの病変組織の容量率と上記データベースとを用いて任意の将来の時点の各組織の病変組織容量率を求める予測計算を行う。

【０００８】本発明の別の特徴は、上記データベース蓄

積手段は、病変組織の容量率と発現症状を検索キー項目として作成された症例データベースをさらに蓄積しており、上記処理装置は、予測計算の結果で得た各臓器、各組織の病変組織の容量率を降順にソートし直し、対応する組織番号をキー項目として容量率の大きい病変組織から順に上記症例データベースを検索する点にある。

【０００９】本発明のさらに別の特徴は、データベース蓄積手段は薬品名に対応する治癒組織番号とその治癒速度を示す投薬データベースを更に蓄積するものであり、上記処理装置は上記病変進行途中における投薬データと上記を投薬データベースを用いて投薬効果を加味した任意の将来の時点の上記各内部組織ごとの病変組織の容量率を予測計算する点にある。

【００１０】本発明の代表的実施例における処理装置のソフトウエアは次のサブルーチンからなる。

【００１１】（１）ある時間ステップで各臓器、組織の病変組織の容量率分布図を出力すること、（２）設定した臓器、組織の相互作用下で次の時間ステップの容量率を計算すること、（３）容量率を値の大きい順にソートし、それらに対応した組織番号を検索キー項目として症例データベースを検索し、その時点で患者に発現する症状を出力すること、（４）あらかじめ投薬データベースで指定した時間ステップにおいて、その投薬薬品名をキー項目として、その対象組織番号と治癒速度を取り出し、容量率データを変換すること。

【００１２】

【作用】本発明によると従来医者の裁量で決められていた疾病の進行予測と投薬、手術、入退院時期の決定におけるエキスパート性をソフトウエア上で実現できる。これにより医師の経験の有無による裁量の差により患者のその後の容体に大きな差が生じないように医師を支援できる。

【００１３】

【実施例】図１は本発明の実施例の予測システムの概略を示す図である。図中２０．２６は処理装置の中の予測計算の対象とする臓器組織間ネットワークモデルを示している。体液循環により病変の転移可能性のある複数の臓器１０をその転移経路１２で結合し、かつ各臓器を複数の内部組織に分割したのがこの臓器組織間ネットワークモデルである。たとえば脳を１、肺を２、心臓を３、胃を４、肝臓を５、・・・のように各臓器に番号をつける。それぞれの臓器を複数の内部組織に分割し順に番号をつける。臓器番号、組織番号をまとめ（５，２）と記す場合には肝臓の第２組織を意味する。組織（ｉ，ｊ）＊

＊の全容量に占める病変組織容量の割合をＮ（ｉ，ｊ）と定義する。ここでＮは一般に０以上１以下の変域をとりＮ＝０は正常組織であることを意味する。

【００１４】予測システムには、現時点、つまりｔ＝０における対象の患者のＮ（ｉ，ｊ）の検診結果が予測計算の初期条件１８として入力される。Ｎ（ｉ，ｊ）の評価法としては、例えばＣＴやレントゲン写真から目視あるいは自動判別された病変の面積を対象組織の前面積で割った数値を用いる。具体的には初期条件１８は、患者名、疾病名、臓器番号ｉ、組織番号ｊ、それらのＮ（ｉ，ｊ）からなり、対話型入力装置からキー入力する。

【００１５】処理装置は図１の２０に示す表示を行うため、初期条件入力にしたがってデータを表示装置に出力する。図中の長方形１４は各組織に対応し、ハッチングされた区域１５はＮがあるしきい値以上である組織を表している。この様な臓器組織間ネットワークモデル上に対象患者の現在の病変分布を表して表示することにより、患者の病状もしくは手術、投薬が必要な組織を視覚的イメージで把握できる。病変分布のもう一つの表現法は各臓器の各内部組織のＮの値と色を対応させカラー出力装置に表示する方法である。例えば、Ｎの値が大きくなるにつれて暖色系の色を指定し、正常組織は寒色表現する。

【００１６】処理装置は病変の増殖、転移を時間発展問題として数学的に解く。このためＮの時間変化率に関しての非線形微分方程式を導入する。Ｎ（ｉ，ｊ）の時間変化率をＭ（ｉ，ｊ）とすると、この変数依存性は自己増殖の他に（ｉ，ｊ）に隣接する組織（ｉ，ｋ）のＮ（ｉ，ｋ）に依存するのみならず他の臓器とのネットワークを通じて他の臓器組織（ｍ，ｎ）（ｍはｉに等しくない）のＮ（ｍ，ｎ）にも依存する。よってＭ（ｉ，ｊ）を次の３項で記述する。

１．自己増殖：これはＮ（ｉ，ｊ）の２乗に比例する。比例係数をＡ（ｉ，ｊ）　、あるいは略してＡとする。

２．同一臓器内の他の組織（ｉ，ｋ）からの転移：これはＮ（ｉ，ｊ）とＮ（ｉ，ｋ）の積に比例する。比例係数をＢ（ｉ，ｊ，ｉ，ｋ）、あるいは略してＢとする。

３．異なる臓器の他の組織（ｍ，ｎ）からの転移：これはＮ（ｉ，ｊ）とＮ（ｍ，ｎ）の積に比例する。比例係数をＣ（ｉ，ｊ，ｍ，ｎ）、あるいは略してＣとする。

【００１７】以上からＭ（ｉ，ｊ）は、

$$M(i,j)=A(i,j)*N(i,j)*N(i,j)+B(i,j,i,k)*N(i,j)*N(i,k)+C(i,j,m,n)*N(i,j)*N(m,n) \quad (数1)$$

となる。（数１）の左辺は時間変化率であるので差分法の評価に従ってＭ（ｉ，ｊ）を１時間ステップ後のＮ'（ｉ，ｊ）と現在のＮ（ｉ，ｊ）の差として（数２）で評価する。

$$M(i,j)=(N'(i,j)-N(i,j))/DT \quad (数2)$$

ここでDTは1時間ステップ幅である。

【0018】（数1）、（数2）からある時間ステップ＊ ＊のN（i，j）が与えられればその1時間ステップ後のN'（i，j）を（3）で計算できる。

$$N'(i,j)=N(i,j)+DT\{A(i,j)*N(i,j)*N(i,j)+B(i,j,i,k)*N(i,j)*N(i,k)+C(i,j,m,n)*N(i,j)*N(m,n)\} \quad (数3)$$

（数3）を計算した後、全てのi，jに対して、

$$N(i,j)=N'(i,j) \quad (数4)$$

とおいて再び（1）、（2）の計算を繰り返す。

【0019】（数3）の係数Aは、病巣組織細胞を自己培養させた時の細胞数の増殖曲線をA＊N＊Nの曲線に内挿して決定する。係数B，Cは対応する疾病に関する臨床データから疾病の組織間転移データを次のように作成する。同一臓器内の他の組織（i，k）から（i，j）への転移について及び異なる臓器の他の組織（m，n）から（i，j）への転移についてはそれぞれ図4及び図5のような帳票項目で転移件数データベースを構築する。図4ではi，j，k、転移件数．図5ではi，j，m，n，転移件数をそのキー項目とする。すなわち．図1のデータベース蓄積手段22には各臓器．組織間の相互作用のデータとして各臓器の各内部組織の病巣組織の自己培養の結果得た係数Aのデータベースと、図4に示す臓器内の組織間の移転件数のデータベースから算出した係数Bのデータベースと、図5に示す臓器間の移転件数のデータベースから算出した係数Cのデータベースが含まれる。処理装置は入力した初期条件とこれらのデータベースとを用い．（数3）の計算を繰り返して任意の将来の時点t（例えば1ヵ月後）のN'（i，j）値を各（i，j）について求める。その結果を初期の病変分布と同様に表示装置に出力し．例えば図1の26に示すように表示する。

【0020】以上の病変分布予測、及び表示を行うシス※

$$N'(i,j)=N'(i,j)*\exp(-V(i,j)*DT) \quad (数5)$$

と置き換えることにより投薬効果を加味した病変分布の予測計算が可能となる。

【0023】この投薬による治癒効果を加味した場合の処理装置における処理フローを図2に示す。指定したステップ回数だけ演算を繰返し、すべてのi，jに対してNの将来の値を求め、先に述べたとおり表示装置に図1の26のように表示する。この様な予測処理により、投薬時期を種々設定して病状の推移を予想することができ．適切な投薬時期の判断に役立つ。

【0024】図1の実施例では、このようにして得られた将来のある時点の病変分布から、その時に患者に現われると予測される症状を例示する。このため病状予測システムは各臓器の各組織の病変組織の容量率に対応する症例を列記した症例データベース28を備える．処理装置は図3に示すフローの処理を行う。まず計算して得た各臓器の各内部組織ごとの病変組織の容量率の予測値N（i，j）を値の降順にソートする。次に対応する組織番号を検索キー項目として容量率の大きい順から症例データベースを検索する。これらの症例項目を表示装置に出力する。例えば、Nの値によって出力文字表示色を分け．緊急度の高い症例は暖色系で、緊急度の低い症例には寒色系の表示するのが好ましい。さらに、特に緊急の治療を要する症例に対しては文字表示を点滅させる等により．医師に注意を促すことができる。

【0025】

【発明の効果】以上のように本発明によれば、相互に関連する複数の臓器についてこれからの病状進行．もしくは投薬による治療効果を．経験によらず医師が的確に予測することを支援できる。したがって．投薬時期．入院時期．もしくは手術時期を医師が適切に判断することが

※テムによれば．実経験によらずに入院時期、投薬時期、手術時期等の医師の判断を支援することができる。また医師の学習の支援システムとして有効である。

【0021】図1の実施例のデータベース蓄積手段22にはさらに薬品名を検索キーとしてその薬品によって治癒する臓器番号i、組織番号j、及び治癒速度をV（i，j）を記録した投薬データベースが蓄積されている。上述した将来の病状予測の計算は．ある時期に投薬したことを仮定してそれによる治癒効果を加味して行うことができる。

【0022】すなわち、各時間ステップiごとに投薬をするかどうかを示す配列変数F（t）を立てておく。F（t）＝0はこの時間ステップで投薬をしないことを意味し．F（i）＝1は投薬することを意味する。この配列変数F（t）は、対話型入力装置に薬品名、投薬時間のデータ24を入力することにより処理装置で作成される。（数3）．（数4）の計算では時間ステップごとにこのフラグをチェックしておき、F（t）＝1ならば以下の投薬によるNの変更計算をtに対して実行する。この変更計算では．まず薬品名を検索キーとして投薬データベースを検索し、薬品によって治癒する臓器番号i，組織番号j，及び治癒速度をV（i，j）を投薬データベースから出力する。次にF（t）＝1の時点の次の時間ステップでのN'を

可能となる。にさらにアルコール依存症や慢性的な中毒などに陥っている患者への警告のために用いても効果がある。

【図面の簡単な説明】

【図１】本発明の予測システムの概略構成を示す概念図である。

【図２】実施例の時間発展計算のフローチャートである。

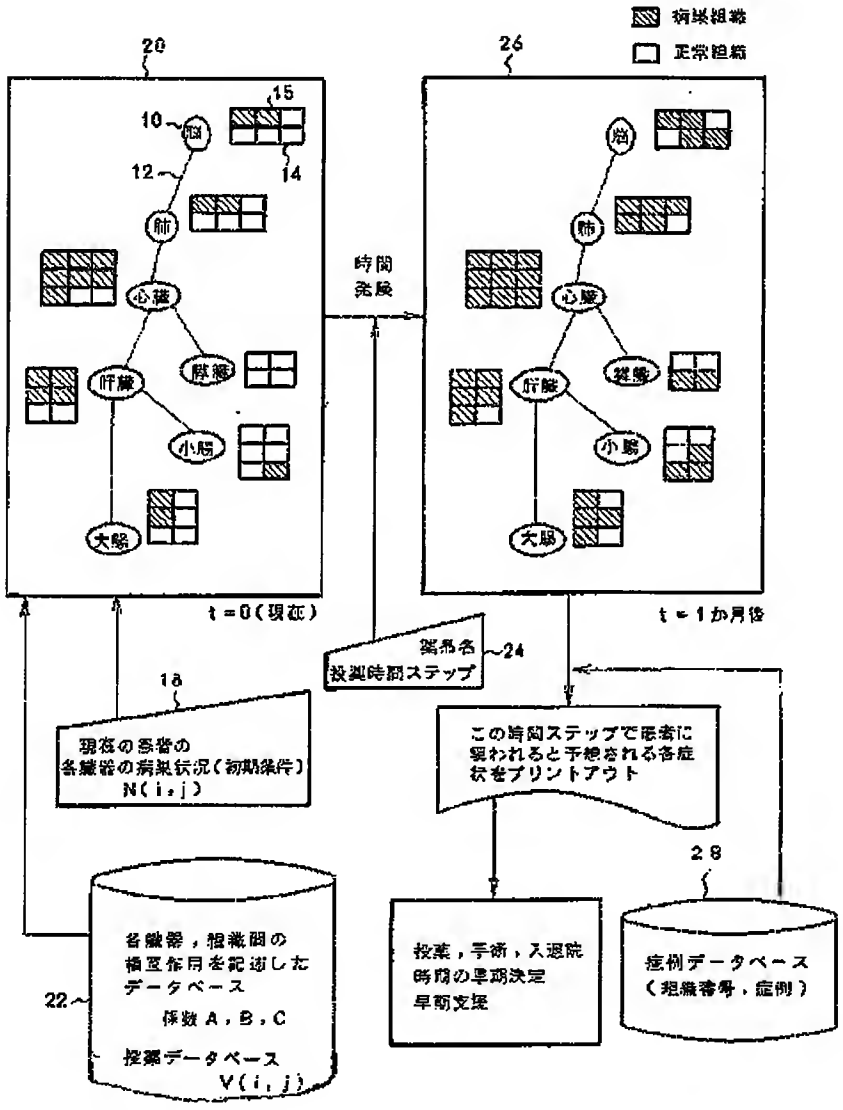
【図３】実施例の時間発展計算の最終ステップでの容量率から症例を出力するフローチャートである。

【図４】実施例の同一臓器内の異なる組織間の転移件数データベース構造を示す図である。

【図５】実施例の異なる臓器間の組織間の転移件数データベース構造を示す図である。

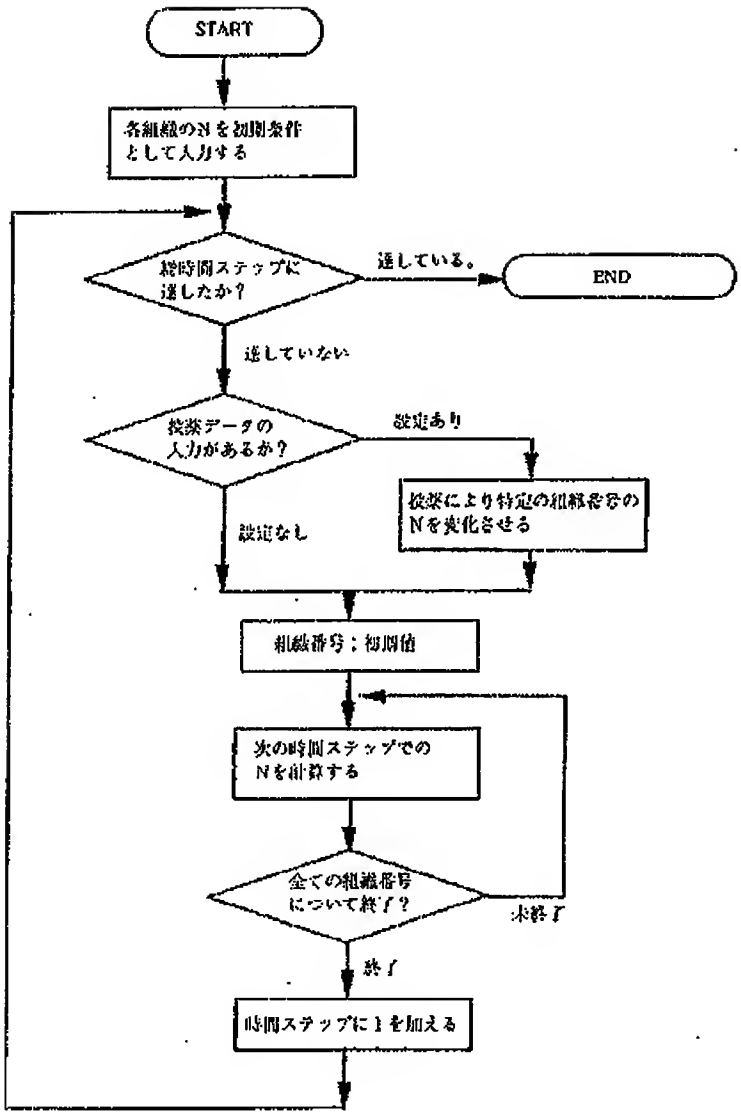
【図１】

図 1



【図2】

図2



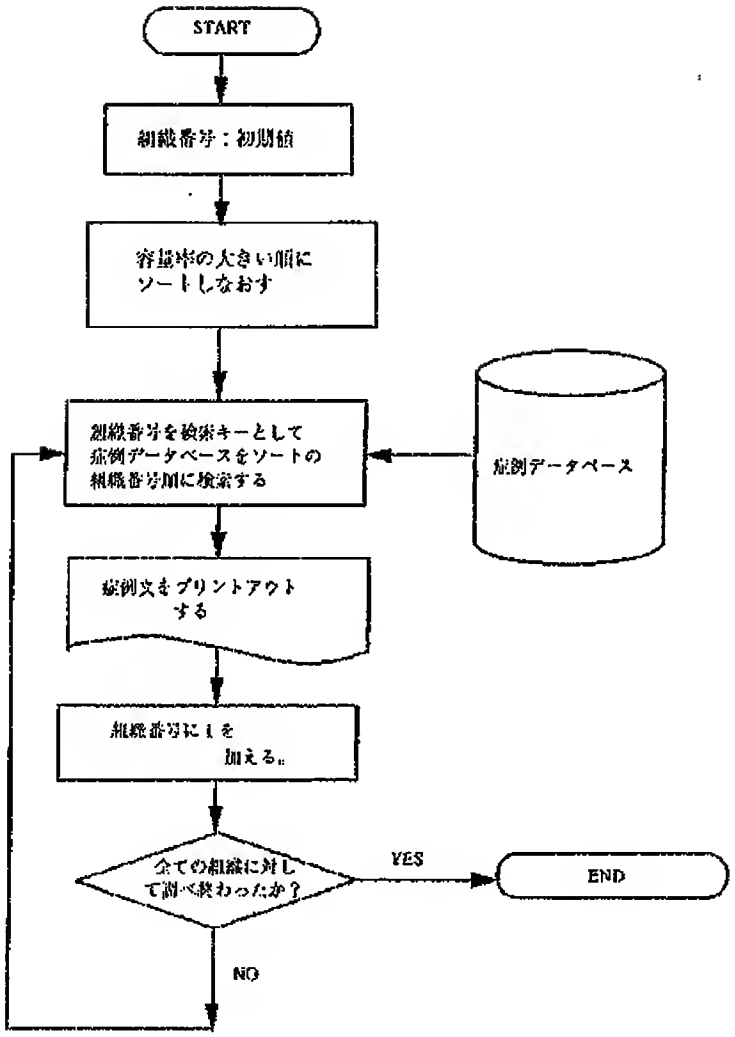
【図4】

図4

i	j	k	件数
1	2	1	2
		5	3
2	1	3	1
3	5	1	7
		1	4

【図3】

図3



【図5】

図5

i	j	m	n	件数
2	1	3	4	1
2	3	3	7	2
5	1	1	2	1
7	…	…	…	…

フロントページの続き

(72)発明者 橋詰 明英
東京都国分寺市東恋ヶ窪1丁目280番地
株式会社日立製作所中央研究所内